

CLAIMS

1. An optical element holding device for holding an optical element, the optical element holding device
5 comprising:

a frame member;

a holding member, arranged in the frame member, for holding the optical element;

10 a displacement portion displaced in a direction intersecting with an optical axis of the optical element by a driving force applied from outside the frame member; and

a transmission portion for transmitting displacement of the displacement portion to the holding member, wherein the transmission portion displaces the holding member in a
15 direction substantially parallel to the optical axis of the optical element.

2. The optical element holding device according to claim 1, wherein the displacement portion is displaced within
20 a plane that is orthogonal to the optical axis of the optical element.

3. The optical element holding device according to claim 1 or 2, further comprising:

25 a driving member, attached to the frame member, for generating the driving force, wherein the driving member urges the displacement portion in a direction intersecting with the optical axis of the optical element.

30 4. The optical element holding device according to claim 1 or 2, further comprising:

a driving member, attached to the frame member, for generating the driving force, wherein the frame member is annular and has a center, and the driving member urges the
35 displacement portion toward the center of the frame member.

5. The optical element holding device according to claim 3 or 4, wherein the driving member includes:

a driving element; and

a housing, connected to the displacement portion, for
5 accommodating the driving element.

6. The optical element holding device according to claim 5, wherein the housing includes a coupling portion for transmitting a driving force generated by the driving element
10 to the displacement portion.

7. The optical element holding apparatus according to any one of claims 3 to 6, wherein the driving member includes a rough adjustment mechanism for roughly adjusting the
15 position of the holding member, and a fine movement mechanism for finely adjusting the position of the holding member.

8. The optical element holding device according to claim 7, wherein the fine movement mechanism includes a
20 piezoelectric element.

9. The optical element holding device according to any one of claims 1 to 8, further comprising:

a guiding portion for guiding the displacement portion
25 in a manner that the displacement portion is displaced in a limited direction.

10. The optical element holding device according to any one of claims 1 to 9, further comprising:

30 an urging member, arranged between the displacement portion and the frame member, for urging the displacement portion toward the frame member.

11. The optical element holding device according to
35 any one of claims 1 to 10, wherein the transmission portion is

a rod having one end, connected to the holding member in a manner rotatable and tiltable in any direction, and another end, connected to the displacement portion in a manner rotatable and tiltable in any direction, with the one end and the other end of the rod being connected by an axis tilted relative to a direction in which the displacement portion is displaced.

12. The optical element holding device according to claim 11, wherein the displacement portion is one of three displacement portions that are arranged on the frame member, and the transmission portion is one of three transmission portions associated with the displacement portions, with each transmission portion including two rods connected to the associated displacement portion.

13. The optical element holding device according to any one of claims 1 to 12, further comprising:

a vibration attenuating mechanism, arranged between the frame member and the displacement portion, for attenuating vibration of the displacement portion generated by the driving force.

14. The optical element holding device according to claim 13, wherein the vibration attenuating mechanism includes a friction member fixed to one of the frame member and the displacement portion and slidably contacting the other one of the frame member and the displacement portion.

15. The optical element holding device according to any one of claims 9 to 14, wherein at least two of the frame member, the displacement portion, the guide portion, and the transmission portion are monolithically formed as a single structure body.

16. The optical element holding device according to claim 15, wherein the single structure body is formed through engraving machining and includes a connecting portion connecting the at least two of the frame member, the displacement portion, the guide portion, and the transmission portion to one another.

17. The optical element holding device according to claim 16, wherein the connecting portion is formed by a plurality of connecting portions connecting in a relatively movable manner the frame member and the guide portion, the displacement portion and the guide portion, the displacement portion and the transmission portion, and the transmission portion and the holding member.

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18. The optical element holding device according to any one of claims 1 to 17, further comprising:

a displacement detection mechanism including a detector, arranged inside the frame member, for detecting displacement of the holding member; and

a monitoring portion, arranged outside the frame member, for monitoring a detection result of the detector from outside the frame member.

19. The optical element holding device according to claim 18, wherein the detector displays a detection result, and the monitoring portion reads the detection result while maintaining the frame member in an hermetically sealed state.

20. The optical element holding device according to any one of claims 1 to 19, further comprising:

a seal for isolating an inner space of the frame member from the outer side of the frame member and hermetically sealing the inner space of the frame member.

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21. A barrel comprising:

an optical element; and

the holding device according to any one of claims 1 to 20 that holds the optical element.

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22. The barrel according to claim 21, wherein the optical element is one of a plurality of optical elements constituting a projection optical system for projecting an image of a predetermined pattern formed on a mask onto a substrate.

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23. An exposure apparatus for exposing an image of a predetermined pattern onto a substrate, the exposure apparatus comprising:

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a mask on which the image of the predetermined pattern is formed; and

the barrel according to claim 22 that transfers the image onto the substrate.

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24. A device manufacturing method comprising:

a lithography process including exposure performed with the exposure apparatus according to claim 23.